through multiple wavelengths for obtaining spectral information by measuring an intensity of the beam at each wavelength.

The radiation that traverses the etalon 20 on a first pass is incident upon a retro-reflector 24 and is redirected anti-parallel, and preferably within 0.1° or less of perfectly anti-parallel, to its incident direction back toward the etalon 20 that is preferably within the housing 22. The radiation then traverses the etalon 20 on a second pass. Although not shown in Figure 5, the radiation may traverse the etalon 20 on a third pass, such as according to the arrangement schematically shown in Figure 3.

The radiation, after traversing the etalon 20 on at least a second pass, is then preferably incident upon a lens 26 that focuses the radiation onto a photodiode 28 for detecting the intensity of the radiation. The intensity information is preferably transmitted for data processing 32 such as to a computer. The intensity information may go through a counter 30 an then to data processing 32.

OVERALL LASER SYSTEM

Figure 6 schematically illustrates an overall excimer or molecular fluorine laser system according to a preferred embodiment which preferably includes the advantageous features described above with reference to Figures 1-5. Referring to Figure 6, a preferred excimer or molecular fluorine laser system is a DUV or VUV laser system, such as a KrF, ArF or molecular fluorine (F_2) laser system, for use with a deep ultraviolet (DUV) or vacuum ultraviolet (VUV) lithography system. Alternative configurations for laser systems for use in such other industrial applications as TFT annealing, photoablation and/or micromachining, e.g., include configurations understood by those skilled in the art as being similar to and/or modified from the system shown in Figure 6 to meet the requirements of that application. For this purpose, alternative DUV or VUV laser system and component configurations are described at U.S. patent applications no. 09/317,695, 09/244,554, 09/452,353, 09/512,417, 09/599,130, 09/694,246, 09/712,877, 09/574,921,

09/738,849, 09/718,809, 09/629,256, 09/712,367, 09/771,366, 09/715,803, 09/738,849, 09/791,431, 60/204,095, 09/741,465, 09/574,921, 09/734,459, 09/741,465, 09/686,483, 09/584,420, 09/843,604, 09/780,120, 09/792,622, 09/791,431, 09/811,354, 09/838,715, 09/715,803, 09/717,757, 09/771,013, 09/791,430, 09/712,367 and 09/780,124, and U.S. patents no. 6,285,701, 6,005,880, 6,061,382, 6,020,723, 6,219,368, 6,212,214, 6,154,470, 6,157,662, 6,243,405, 6,243,406, 6,198,761, 5,946,337, 6,014,206, 6,157,662, 6,154,470, 6,160,831, 6,160,832, 5,559,816, 4,611,270, 5,761,236, 6,212,214, 6,243,405, 6,154,470, and 6,157,662, each of which is assigned to the same assignee as the present application and is hereby incorporated by reference.

DISCHARGE TUBE

The system shown in Figure 6 generally includes a laser chamber 102 (or laser tube including a heat exchanger and fan for circulating a gas mixture within the chamber 102 or tube) having a pair of main discharge electrodes 103 connected with a solid-state pulser module 104, and a gas handling module 106. The gas handling module 106 has a valve connection to the laser chamber 102 so that halogen, any active rare gases and a buffer gas or buffer gases, and optionally a gas additive, may be injected or filled into the laser chamber, preferably in premixed forms (see U.S. patent applications no. 09/513,025, 09/780,120, 09/734,459 and 09/447,882, which are assigned to the same assignee as the present application, and U.S. patents no. 4,977,573, 4,393,505 and 6,157,662, which are each hereby incorporated by reference. The solid-state pulser module 104 is powered by a high voltage power supply 108. A thyratron pulser module may alternatively be used. The laser chamber 102 is surrounded by optics module 110 and optics module 112, forming a resonator. The optics modules 110 and 112 may be controlled by an optics control module 114, or may be alternatively directly controlled by a computer or processor 116, particular when line-narrowing optics are

included in one or both of the optics modules 110, 112, such as is preferred when KrF, ArF or F_2 lasers are used for optical lithography.

PROCESSOR CONTROL

The processor 116 for laser control receives various inputs and controls various operating parameters of the system. A diagnostic module 118 receives and measures one or more parameters, such as pulse energy, average energy and/or power, and preferably wavelength, of a split off portion of the main beam 120 via optics for deflecting a small portion 122 of the beam toward the module 118, such as preferably a beam splitter module 121. The beam 120 is preferably the laser output to an imaging system (not shown) and ultimately to a workpiece (also not shown) such as particularly for lithographic applications, and may be output directly to an application process. The laser control computer 116 may communicate through an interface 124 with a stepper/scanner computer, other control units 126, 128 and/or other external systems.

The processor or control computer 116 receives and processes values of some of the pulse shape, energy, ASE, energy stability, energy overshoot for burst mode operation, wavelength, spectral purity and/or bandwidth, among other input or output parameters of the laser system and output beam. The processor may receive signals corresponding to the wavefront compensation such as values of the bandwidth, and may control the wavefront compensation performed by the wavefront compensation optic 3, 13, 23 (see above) in a feedback loop by sending signals to adjust the pressure(s) and/or curvature(s) of surfaces associated with the wavefront compensation optic 3, 13, 23. The processor 116 also controls the line narrowing module to tune the wavelength and/or bandwidth or spectral purity, and controls the power supply and pulser module 104 and 108 to control preferably the moving average pulse power or energy, such that the energy dose at points on the workpiece is stabilized around a desired value. In addition, the computer 116 controls the gas handling module 106 which